attenuated by the directivity of the antenna beam which defines the super-cells, and by the "processing gain", that is the ratio of total bandwidth to user band-bandwidth.

TIME DELAY DIVERSITY

Multipath is perhaps the number one curse of conventional mobile radio telephone. By contrast, in the **CELSTAR** system, the wide bandwidth inherent in Spread Spectrum is used to resolve the various components of multipath, and enable them to be combined constructively, in a three-fold, delay tracking RAKE receiver to provide a high degree of immunity to fading. This principle has been demonstrated with great success in the recent series of ground cellular CDMA field trails in San Diego. (See, "Next Generation Cellular - Results of the Field Trials", CTIA, December 4-5, 1991, Washington D.C.)

SOFT HANDOVER

The same RAKE mechanism provides the basis for soft handover, with enhanced signal performance at the critical maximum range by utilizing the two nearly equal signals from the two (or three) competing transmitters and beams as components of a time diversity pair (or triad). This has also been demonstrated effectively in the above referenced San Diego CDMA cellular field trials.

CDMA/FDMA HYBRID

In CELSAT the total bandwidth for each link is first divided into 1.25 MHZ subbands. Each subband in each cell is then shared by about 40 simultaneous users using Code Division Multiple Access. This has several important advantages:

1. It is compatible with the emerging standard for ground cellular CDMA.

2. The resolution provided is adequate to support an RDSS ranging accuracy objective of 300 yards (normal mode) and to resolve the major components of urban multipath.

3. The lower sampling rate makes feasible RAKE implementation with existing DSP chips.

4. The frequency subband separation enables an important degree of flexibility in management of narrow band (1.25 MHz) interference either to or from the CELSAT system.

INTERFERENCE

CDMA affords special advantages with respect to both generated and tolerated interference, of special importance in a band sharing or experimental application.

The system design, for both the ground based and satellite based links, is based upon a cumulative interference level (Noise power spectral density) at maximum channel loading, about equal to or somewhat less than that of thermal noise alone.

Both up-link or outbound, and down-link or in-bound transmitters are continuously power controlled to ensure that each user link continuously and dynamically uses minimum radiated power usage consistent with this criterion. Thus, the worst case (i.e. under maximal channel loading) interference to a narrow band user would be less than 3 dB degradation of absolute sensitivity, which is quite acceptable.

BASEBAND SERVICE FLEXIBILITY

One of the important side benefits of spread spectrum CDMA is the flexibility that it affords in terms of baseband services. Frequently or time division multiplex structures must manage a multiplex strategy which becomes quite complex and inefficient when called upon to accommodate a diverse and dynamically changing mix of different base-bandwidth services. By contrast, in the CDMA mix, there are no such constraining relations between the baseband services other than the total power allocated to all other band sharing services. This means, for example, that it is possible to mix services ranging from minimal data rates of, say, 75 bps to fast data or compressed video of up to 144 kilobits per second. This baseband flexibility will become of special importance to the Emergency Radio Service, which may be called upon to provide a wide range of baseband services ranging from slow physiological monitoring to pictures and compressed video.

VOICE ENCODING

While the art of voice encoding is itself well aged, the impact of powerful microprocessor capabilities and the concept of algorithms such as vector quantization have triggered a significant resurgence of research and breakthrough results in recent years. High communications quality encoding (almost full intelligibility but with slight noticeable unnaturalness) has been demonstrated as low as 2.4 kbps, but with presently unacceptable computational complexity. Initial efforts at simplifying these algorithms and reducing them to ASIC's are showing promising initial results. **CELSAT** believes that the immediate next generation of digital cellular radio will utilize existing demonstrated 8 kbps hybrid encoding, but it also believes that 4 kbps voice ASICs will be available within a few years.

The **CELSTAR** system CDMA approach accommodates gracefully to such anticipated dynamic improvements in encoding performance. New, updated user sets, taking advantage of more powerful encoding algorithms (and either reduced rates or improved fidelity), will operate compatibly in the same wideband RF channel, with sets built to older obsolescent standards, as well as other diverse data and picture services. There is no rate compatibility constraint, only the overall signal power constraint. The CDMA system is designed for growth.

FORWARD ERROR CORRECTION CODING

Another important benefit of the choice of SSCDMA is that is provides for almost arbitrarily powerful, low rate Forward Error Correction coding at no cost in terms of lost circuit capacity. In FDMA or TDMA, the redundancy necessary to implement such coding must be paid for directly in terms of reduced circuit capacity. For example, rate 1/2 FEC coding (50% redundancy) reduces the number of band-limited allocatable TDMA or FDMA voice circuits by almost 1/2. By contrast, in CDMA, such coding does not reduce the number of available circuits, in fact, to the same extent (several dB) that it improves the system sensitivity to noise and interference, it also improves the tolerance to in-band interference and correspondingly <u>increases</u> the number of users that can be accommodated in-band. In other words, the circuit capacity has been improved rather than sacrificed due to FEC encoding. In effect, the redundancy necessary to support FEC is already there in CDMA, at no cost in terms of circuit capacity.

<u>TRANSMITTER POWER LEVEL CONTROL</u>

Mobile Radio is inherently subject to significant dynamic variations of signal strength and fading due to time varying multipath and shadowing, building or foliage attenuation effects. The overall amplitude distribution due to these phenomena is commonly near Rayleigh, and the fading itself is commonly described as Rayleigh fading, even though its actual source may be other than then Rayleigh model. The usual approach to coping with such Rayleigh fading is to provide sufficient brute force transmitter excess power margin to operate above threshold a sufficiently high fraction of the time. Thus, fading margins of as much as 40 dB or so are commonplace in ground cellular service. Hence, on the average, the transmitters are radiating as much as 40 dB more than necessary. This is wasteful of power and creates unnecessarily high levels of spectral interference.

In CDMA systems such a brute force approach is just as undesirable from a power perspective. More importantly, however, increasing everyone's power output by some amount would result in composite interference that is much higher than thermal noise, with resulting increased interference to other systems. Furthermore, while a faded signal might then be still above thermal noise, it would then probably be swamped by the increased level of system self-noise from other equally boosted users.

In the **CELSTAR** concept, each transmitter's power output is dynamically controlled to the minimum desirable value. In this way, the necessary increases of power to work through deep fades are invoked only when needed, with significant savings of average radiated power and its attendant reduction in battery size as well as reduction in interference to other services.

VOICE DUTY CYCLE

Under normal circumstances in a two-way conversation each user is active only 35-40% of the time (including both listening periods and pauses between utterances). In a typically power limited communication link, this represents a potential gain of 4 to 4.5 dB or increase of 2.5 to 2.8 times circuit capacity, if advantage can be taken of these gaps. To capitalize on this in an FDA system leads to a rather complex and limited, centrally coordinated dynamic channel reallocation system such as TASI or DSI. With CDMA on the other hand, there is no problem of channel reassignment -- everyone is already using the same channel. Each channel then needs only VOX control to turn itself off between utterances, independent of all other channels, and the full 4 to 4.5 dB power gain is realized. When a circuit is in the "off" mode, means must be provided to maintain spread spectrum chip synchronization. However, this is easily accomplished at negligible power cost by a low power "keep-alive" signal at a level of the order of 10 dB less than that of the peak "on" signal.

RADIO POSITION DETERMINATION

In the CELSAT system each user transmits a wide-band, code spread signal, in the common allocated subchannel bandwidth, 1.25 Mhz for the nominal baseline system.[1] In order to isolate a particular user signal and demodulate the information on it, the receiver must recreate a local replica of the unique pseudo-noise

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[1] Accommodation can be made for special users to broadcast at the full band width for the highest accuracy, within 100 yards.

signal used for spectrum spreading by that user, and adjust its timing to exactly match that of the incoming signal. The techniques for doing so are well known.

Having made this replica timing adjustment, the receiver inherently has available a precise estimate of the time-of-arrival of the signal. In order for the spread detection to operate, this time must have a precision of about 0.3 microseconds or 300 feet of range. Additionally it is planned that the user clock and code phase would be locked to the received pilot signal phase from his controlling node, thus enabling round trip delay, or range measurement. In conjunction with receptions of each user signal at several ground or satellite nodes which will always be monitoring the signal, this provides the basis for **CELSAT's** position measuring system, capable of position accuracy well within 300 yards. This service is available at very little added system complexity, at very low cost, and without special operator requirements.

SATELLITE, LAUNCH, AND ORBITS

The Arian 4 launch vehicle is suitable for launching a satellite of size shown in Figure 1 and 2, and the **CELSTAR** spacecraft readily fits within its shroud as the 20-meter dish is folded and telescoped in its launched configuration. The spacecraft characteristics supporting **CELSAT's** design were established by a major spacecraft supplier. The resultant spacecraft will perform as indicated in **CELSAT's** application; however, further studies are expected to yield a more optimum configuration with reduced weight, and there is a good possibility of a launch on a less expensive booster, for example the Atlas 2AS, a less expensive Ariane, or the Long March.

The spacecraft bus is a conventional 3-axis system which could be readily supplied by one of several different U.S. vendors and at least one European vendor. For example, the GE7000 bus is a representative bus capable of performing the **CELSTAR** mission. This technology is conventional and well known. Celsat is a service company which will not manufacture hardware. It will instead subcontract for fully insured satellites (bus and payload), launch vehicles, and launch support services on a fixed-price basis from a single major aerospace corporation. Celsat will accept the satellites only after they are completely checked out and functioning to all specifications and at their proper orbital location. Several major aerospace concerns are capable of fulfilling contract requirements. The selected contractor will subcontract for an "off-the-shelf" launch vehicle and launch services.

Orbits

Several years ago, the Celsat founders completed detailed tradeoffs of various orbits, LEO, MEO, and GEO and selected GEO as a clear choice for the service although our patent application permits the use of the concept in any orbit. Subsequent to its decision, there have been other applications filed with the FCC by numerous entities proposing LEO and MEO orbits. When fully analyzed these applications provide substantial detail in support of **CELSAT's** initial selection of GEO orbits. The **CELSTAR** system permits enormously greater spacecraft capacity at a fraction of the cost of the LEO and MEO systems.

The final orbit locations of 76 W and 116 W longitude have been selected to provide mutual coverage of CONUS with good geometry for position determination, while also being able to serve Alaska, Hawaii, and the Virgin Islands.

Launch Sequence

The **CELSTAR** system simply requires a normal Arian 4 launch to geosynchronous orbit followed by a conventional three axis stabilized communication satellite deployment. The sequence is as follows:

- Launch to GEO transfer orbit
- Final orbit injection burn
- Satellite separation from upper stage
- Satellite attitude control system acquisition and stabilization sequence
- Antenna deployment
- Payload initiation
- Complete all on orbit testing

Program Schedule and Milestones

The **CELSTAR** system is well defined at this date and utilizes only conventional technology. Several vendors are available for every element of the system including the satellites and launch vehicles. Since Celstar utilizes geosynchronous satellites, voice, data, compressed video, and a single line of position all are available when the first satellite is placed in service in March of 1996. Position determination is complete with the launch of the second satellite in January of 1998.

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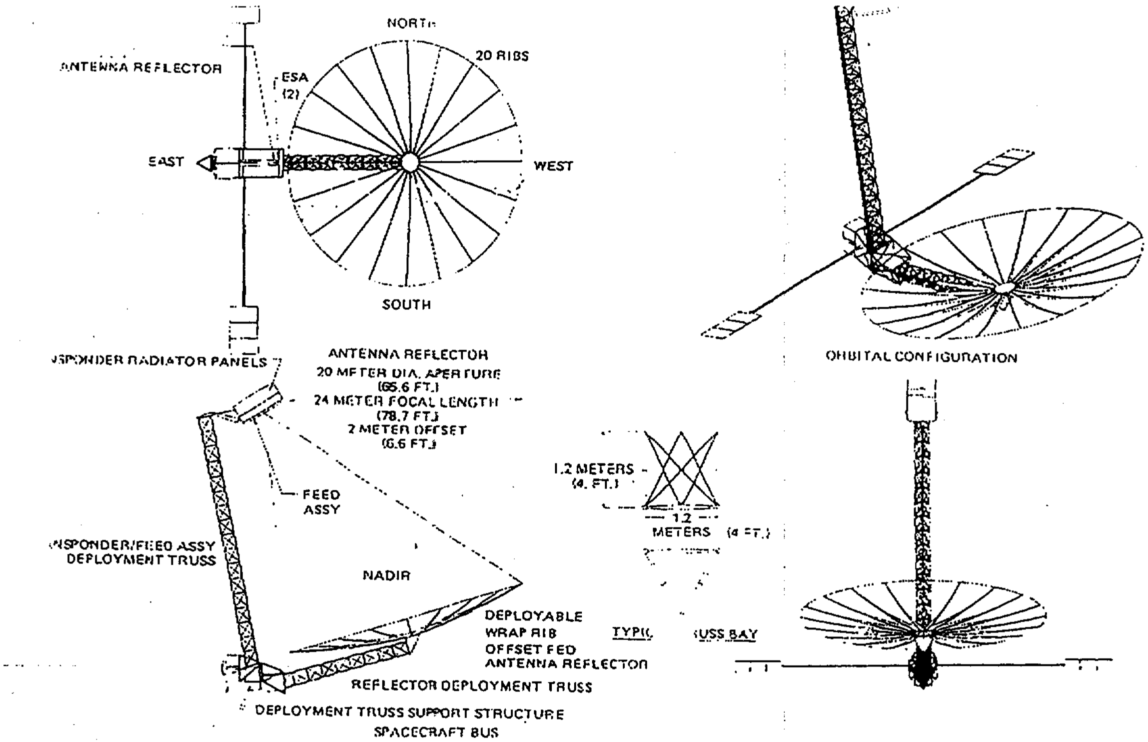
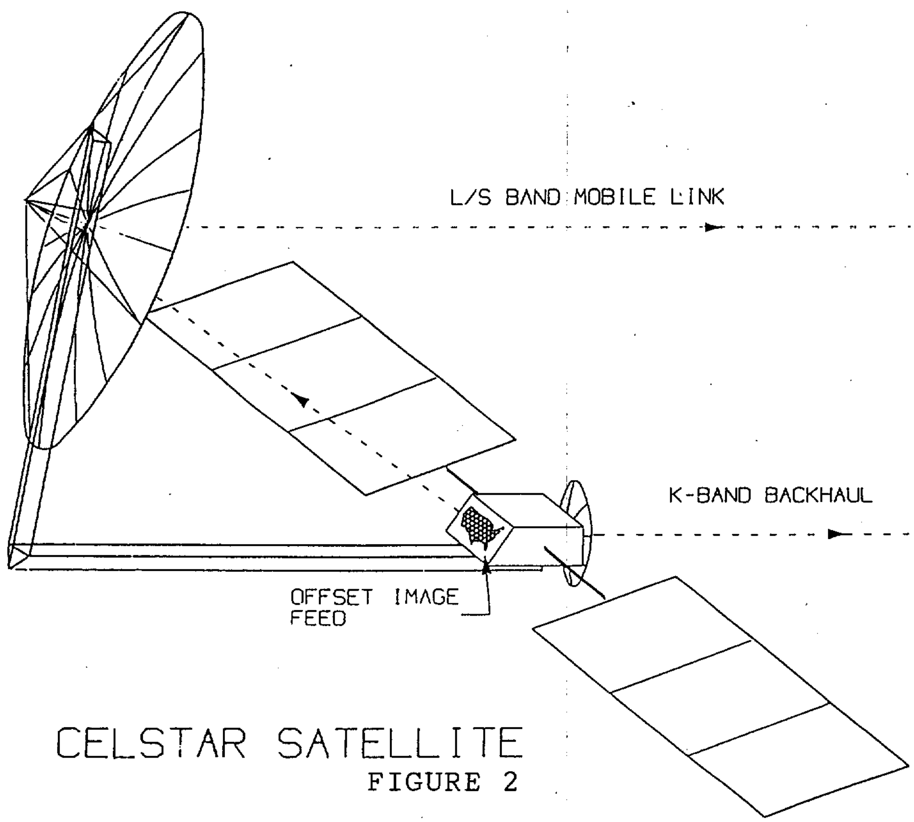
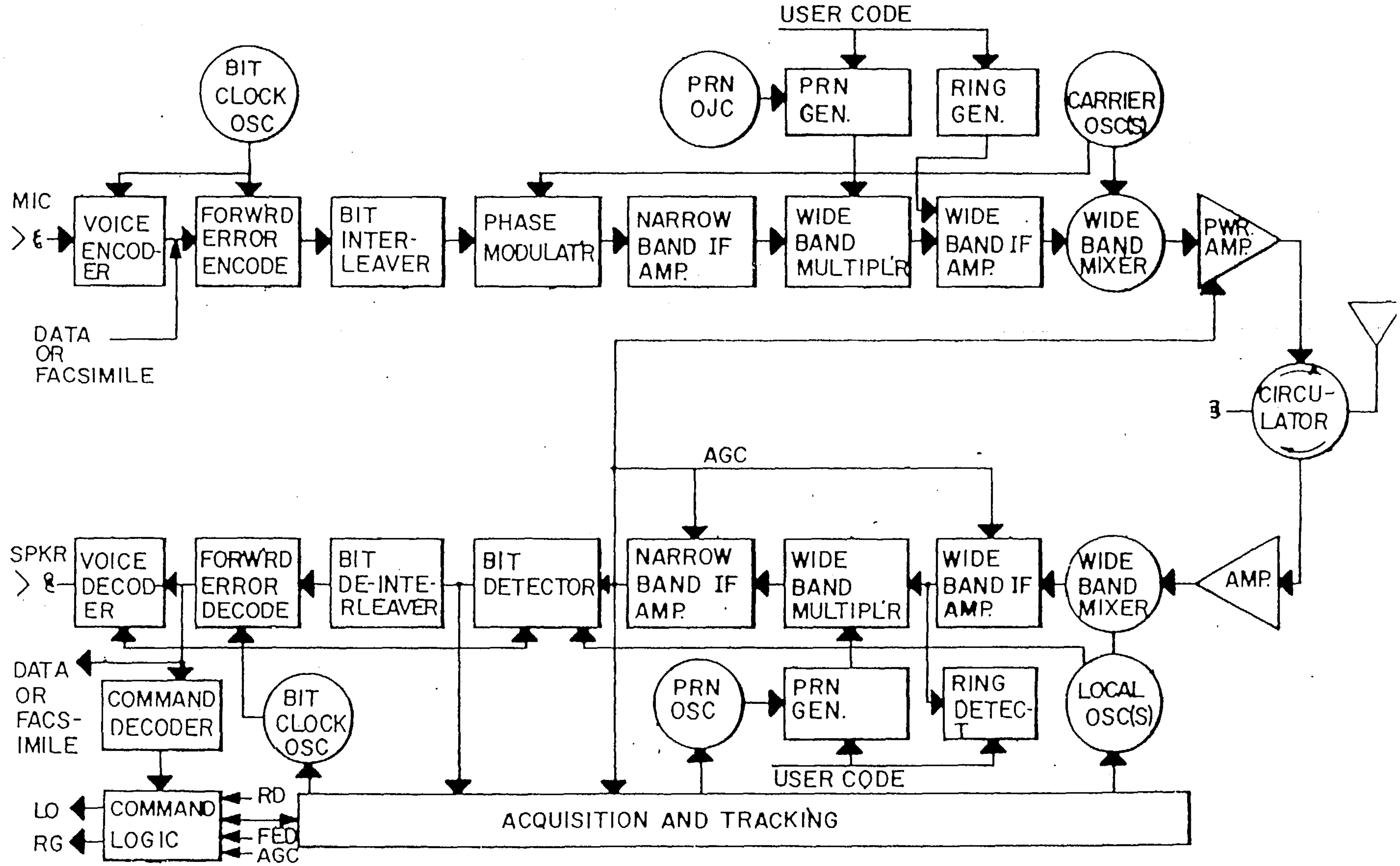


FIGURE 1



CELSTAR SATELLITE
FIGURE 2


USER CODE
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PRN OJC
PRN GEN.
RING GEN.
CARRIER OSC(S)
MIC
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FORWRD ERROR ENCODE
BIT INTER-LEAVER
PHASE MODULATR
NARROW BAND IF AMP.
WIDE BAND MULTIPLR
WIDE BAND IF AMP.
WIDE BAND MIXER
PWR. AMP.
DATA OR FACSIMILE
CIRCU-LATOR
AGC
SPKR
VOICE DECOD-ER
FORWRD ERROR DECODE
BIT DE-INTE-RLEAVER
BIT DETECTOR
NARROW BAND IF AMP.
WIDE BAND MULTIPLR
WIDE BAND IF AMP.
WIDE BAND MIXER
AMP.
DATA OR FACS-IMILE
COMMAND DECODER
BIT CLOCK OSC
PRN OSC
PRN GEN.
RING DETEC-T
LOCAL OSC(S)
USER CODE
LO
RG
COMMAND LOGIC
RD
FED
AGC
ACQUISITION AND TRACKING

FIGURE 3

APPENDIX -- B

APPENDIX B

CELSAT HPCN RADIO FREQUENCY PLAN

Figure B-1 shows the generic frequency plan for the CELSAT system, and Table B-1 shows the specific alternate (Alt-A and Alt-B) frequency sets requested. Where they differ, characteristics of the B alternate are distinguished by square brackets: [nnn].

Backhaul Links

The generic frequency plan, transposed to the appropriate reference frequency describes either alternate frequency request. The <u>backhaul</u> link between hub and satellite is non-critical and occupies 195 [170] MHz(forward) and 185 [160] MHz(reverse) segments in K-Band as shown specifically in the bottom half of Table A-1. The specific frequencies requested are

	DIR	BAND	EMISSION	ANT PWR
Alt-A	UP	29800-29995	190MJ8W-F	5.5 W Avg
	DN	20000-20185	185MJ8W-F	1.1 W Avg
Alt-B	UP	29800 29970	170MJ8W-F	5.5 W Avg
	DN	20000-20160	160MJ8W-F	1.1 W Avg

The K-Band backhaul frequency requests are non-critical and could perform equally at any K- or X- band allocation.

This is an FDM/FDM/CDMA band-spread modulation well adapted to band sharing and is reused some 12 [14] times within the US coverage area by the hybrid CELSAT system. The backhaul trunks are structured as a frequency division multiplex of 10 mobile FDM/CDMA links serving 10 ground cells within a given region plus a 5 MHz spread spectrum TT&C channel. Further band sharing with other services is feasible.

Power into the antennas is given as an average; provision is made for up to 5 dB occasional command increase to cope with rain attenuation. The backhaul link includes a 5 MHz, spread spectrum protected, TT&C channel.

Polarization is LH Circular up, RH Circular down. Transmitting and receiving antenna gains are 50 dB.

Mobile Links

The mobile links are located in either the L or S bands. Alternate A frequency request is based on the proposed new mobile-satellite band allocations to be considered at WARC-92; Alternate B is based onthe L/S Band RDSS allocation. Specific requests are:

	DIR	**BAND (MHz)**	**Emission**	**Ant Pwr**
Alt-A:	Up	2410-2428	18M0J8W-F/C	.1 W Avg.
	Dn	2110-2129	19M0J8W-F/C	15 W Avg.
Alt-B:	UP	1610-1625.5	15M5J8W-F/C	.1 W Avg.
	Dn	2483.5-2500	16M5J8W-F	15 W Avg

Each cell uses 12 [14] 1.25 MHz FDM subbands for the mobile traffic. The same 12 [14] subbands are used in *each* cell by virtue of the CDMA multiplex within the 1.25 MHz band. This is partially responsible for the very high frequency reusage of the system, 112 [149] times over the US.

A middle segment in each downlink band is devoted to the pilot and call service functions. The pilot subband is time-shared among all fixed node-to-mobile transmitters. Each such node transmitter broadcasts bursts of a repeated common short, correlatable code.

Successive bursts are modulated with an FEC encoded node identifier plus short node status word.

The time epoch of each broadcast code burst is offset from system time epoch in a fixed sequence and separation. The time separations are coordinated among neighboring cells such that none of the ground and node pilot signals that can be received in any given region overlap in time epoch within that region. These pilot signals then provide the basis for signal selection and initial Rake receiver alignment.

In addition to the pilot signals, the call setup and control is served by four special 0.125 MHz subbands. Separate call service channels serve the ground and satellite subsystems in the forward and reverse directions. These are managed as assigned time-slot time division (DAMA) channels. Initial call requests and periodic log-ins from each active standby mobile are entered in the reverse direction "log-in" channel, which is managed as a slotted ALOHA system, with slot epochs established by the forward pilot signals discussed above. By this means it is possible to handle all call establishment and control traffic in the most efficient manner.

The user mobile link requests are more critical. In the **CELSAT** concept, S-band is significantly more favorable than L-Band in terms of beam footprint size, frequency reuse, and overall spectral efficiency, US circuits per MHz. Additionally, maximum frequency separation between the uplink and downlink channels plays an important role in the passive inter-modulation control plan. For this reason the primary request is for the lowest portion of the low (space-to-earth) band and the highest part of the high (earth-to-space) band. Nominal polarization is LH circular up and RH circular down.

COVERAGE CONTOURS

Figures B-2 shows how the contiguous United States is covered by the satellite beam cells, as seen from the perspective of the satellite, with the United States appropriately distorted. Three additional, detached cells cover Hawaii, Alaska, and Puerto-Rico/Virgin Islands. The legends is Figures B-3 through B-9 give the range, aspect angles, cell dimensions, and flux density calculations for representative places in the coverage area for both frequency alternates.

Typical satellite cell ground coverage contours are shown in Figures B-3 through 9 as projected on the surface of the earth. Since the antenna size is the same under both frequency alternates, the earth pattern merely scales inversely with frequency as shown in the scaling legend for the two frequency alternates. Note that in both alternates, the cell size is tied to the antenna 3-dB contour at the cell major diameter. By virtue of the fixed geosynchronous geometry, all cells have the same center Gain and nominal EIRP. Note that these EIRP numbers represent full capacity equal traffic loading in all cells. In fact, those cells serving a smaller traffic load will radiate a correspondingly lower EIRP. In particular, this is true of the Alaska cell. Coverage north of Fairbanks does not appear practical without further relaxation of the low angle ITU flux density limitations. Full coverage is provided for the Hawaiian Islands and Puerto-Rico/Virgin Islands at elevation angles above 35 degrees.

The coverage depicted in Figure B-2 is representative as would be seen from a hypothetical satellite at mid-CONUS longitude. In reality, while both satellites, one at 116^0 W. and the other at 76^0 W., could cover all of CONUS in an emergency, normal operation would be to split CONUS down the middle, with each half served by its nearer, and higher elevation satellite. So doing, CONUS elevation angles are always greater than 31 degrees. Coverage as far north as Fairbanks Alaska, including Anchorage and Juneau is at elevation angles of 13 degrees or greater.

FREQUENCY PLAN

01/18/92 14:05

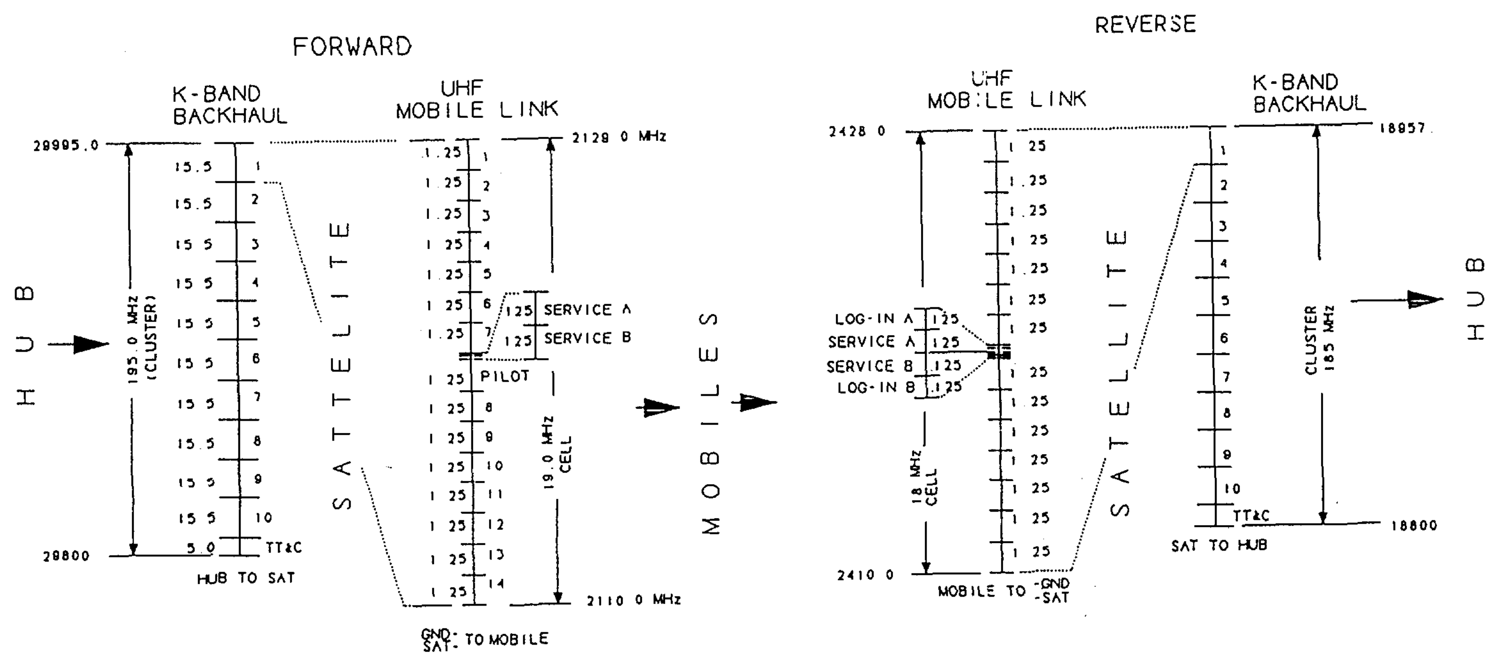
UHF MOBILE LINKS

FUNCTION	ALTERNATE A FORWARD (DOWN) WIDTH MHz	FREQ MHz	REVERSE (UP) WIDTH MHz	FREQ MHz	ALTERNATE B FORWARD (DOWN) WIDTH MHz	FOR'D MHz	REVERSE (UP) WIDTH MHz	REV. MHz
LOWER BAND EDGE		2110		2410		2483.5		1610
PILOT	1.25				1.25			
LOG-IN			0.25				0.25	
CALL SERVIC	0.25		0.25		0.25		0.25	
TRAFFIC	17.5		17.5		15		15	
TOT TOTAL BW	19		18		16.5		15.5	
UPPER BAND EDGE		2129		2428		2500		1625.5

BACKHAUL LINKS 10 CELLS/CLUSTER

FUNCTION	PRIM ALTERNATE A FORWARD (UP) WIDTH MHz	FREQ MHz	REVERSE (DOWN) WIDTH MHz	FREQ MHz	ALTE ALTERNATE B FORWARD (UP) WIDTH MHz	FOR'D MHz	REVERSE (DOWN) WIDTH MHz	REV. MHz
LOWER BAND EDGE		29800		20000		29800		20000
TRAFFIC	190		180		165		155	
TT&C	5		5		5		5	
TOTAL BW	195		185		170		160	
UPPER BAND EDGE		29995		20185		29970		20160

TABLE B-1



HYBRID CELSAT FREQUENCY PLAN

FIGURE B-1

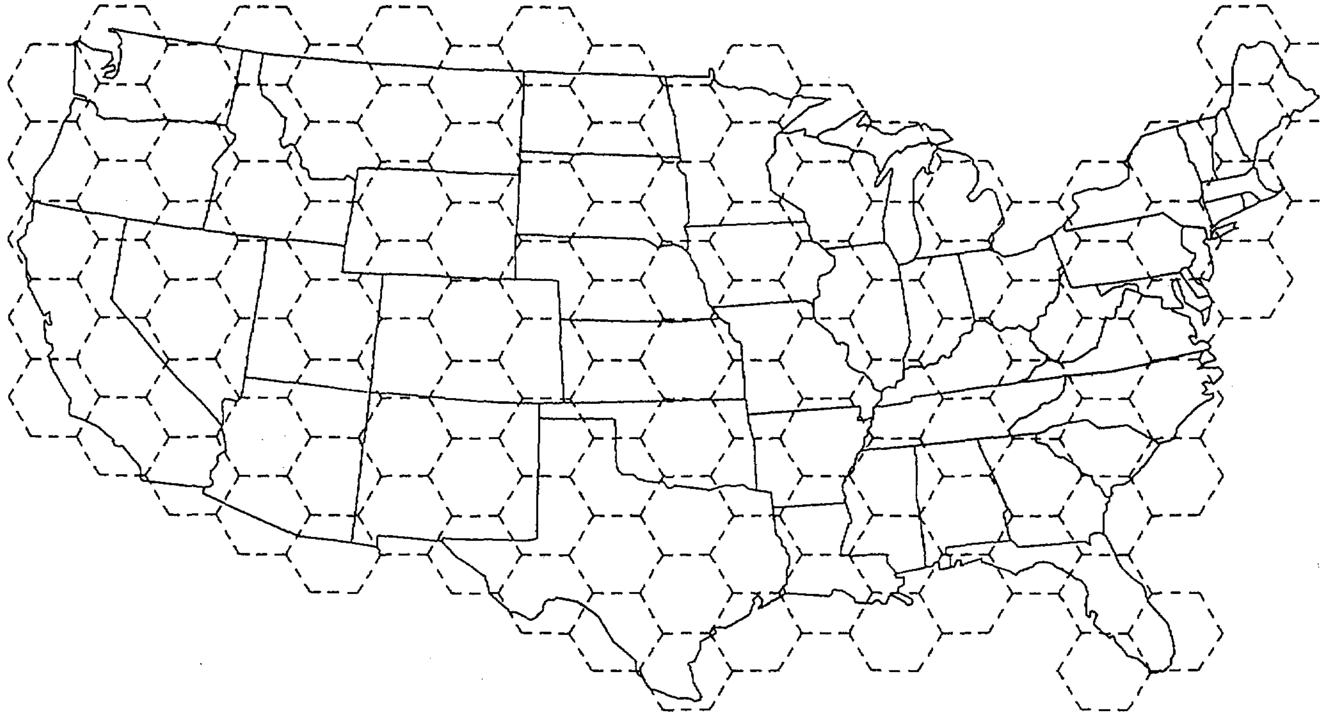
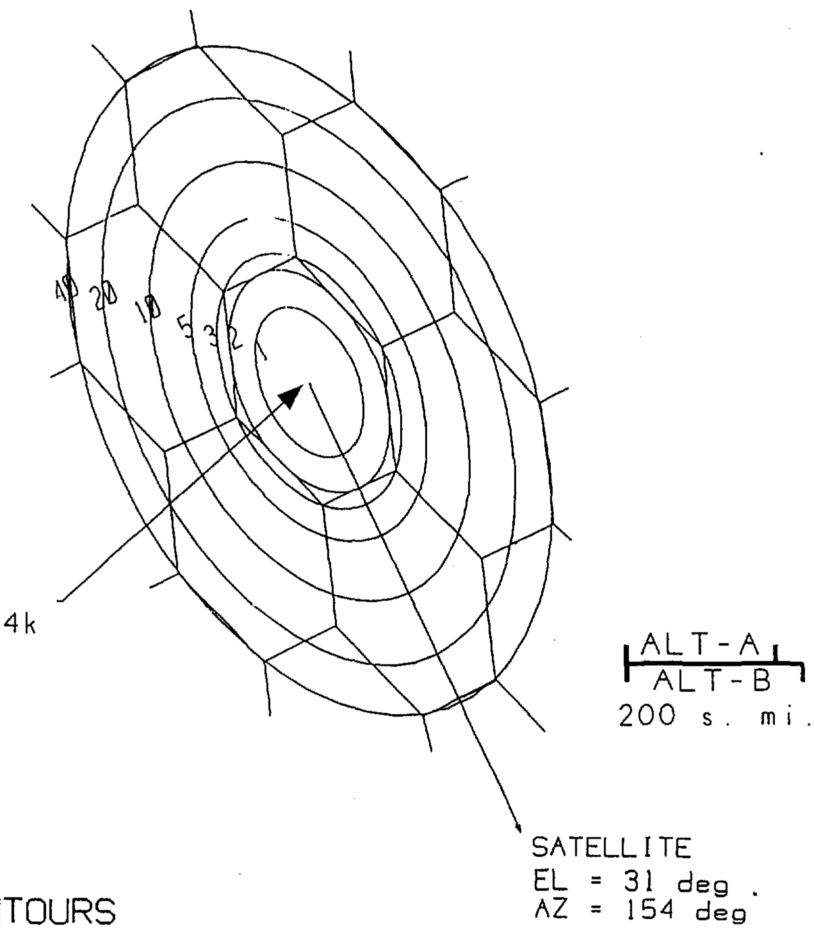


FIGURE B-2

CELSTAR

US SATELLITE CELLULAR COVERAGE

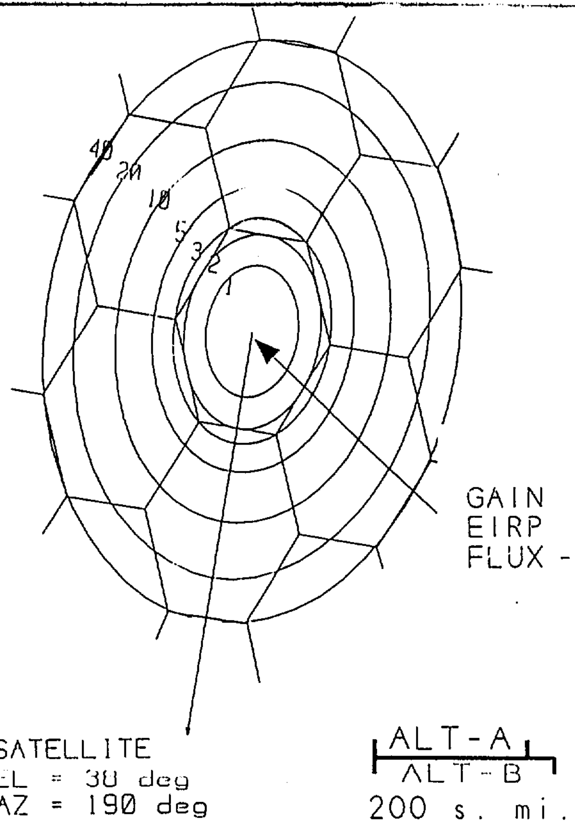
LINE-OF-SIGHT PROJECTION



	ALT-A	ALT-B	
GAIN	47.8	49.2	dB
EIRP	58.6	58.8	dBW
FLUX	-138.9	-138.0	$dBW/m^2/4k$

BEAM PATTERN CONTOURS
76 deg W SATELLITE AT GRAND FORKS

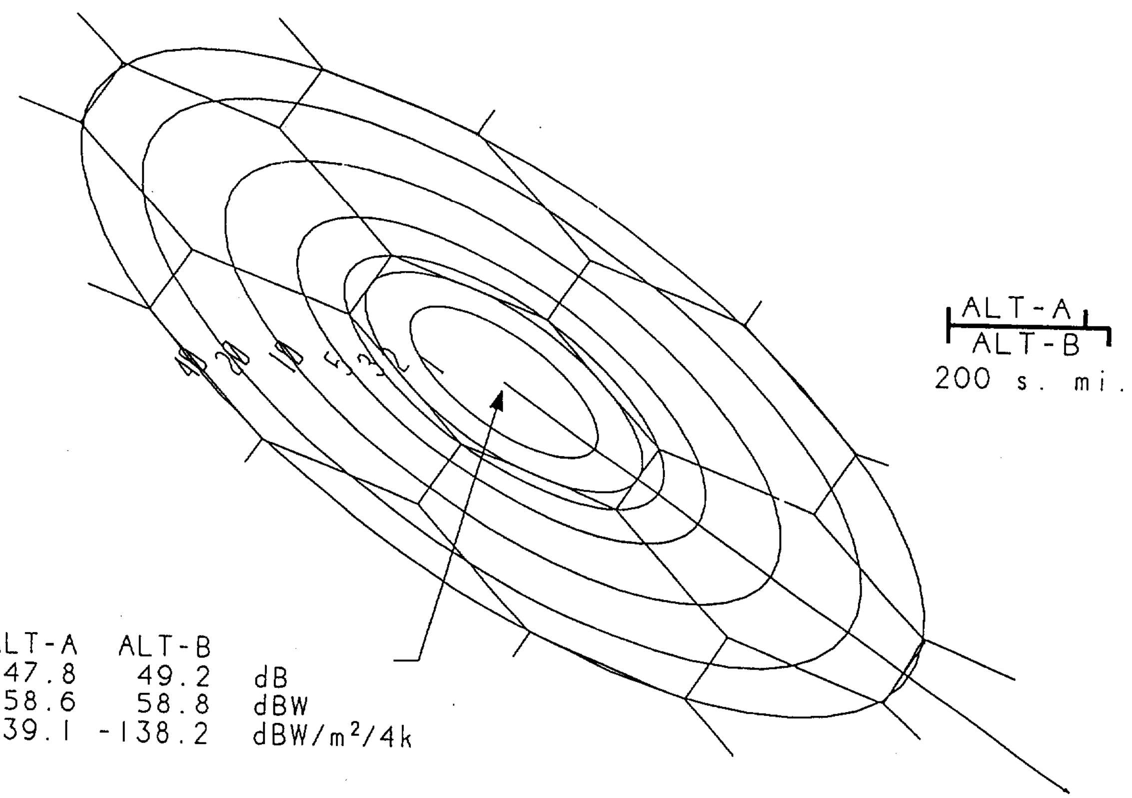
FIGURE B-3



	ALT-A	ALT-B	
GAIN	47.8	49.2	dB
EIRP	58.6	58.8	dBW
FLUX	-138.8	-137.9	$dBW/m^2/4k$

BEAM PATTERN CONTOURS
76 deg W SATELLITE AT BANGOR

FIGURE B-4

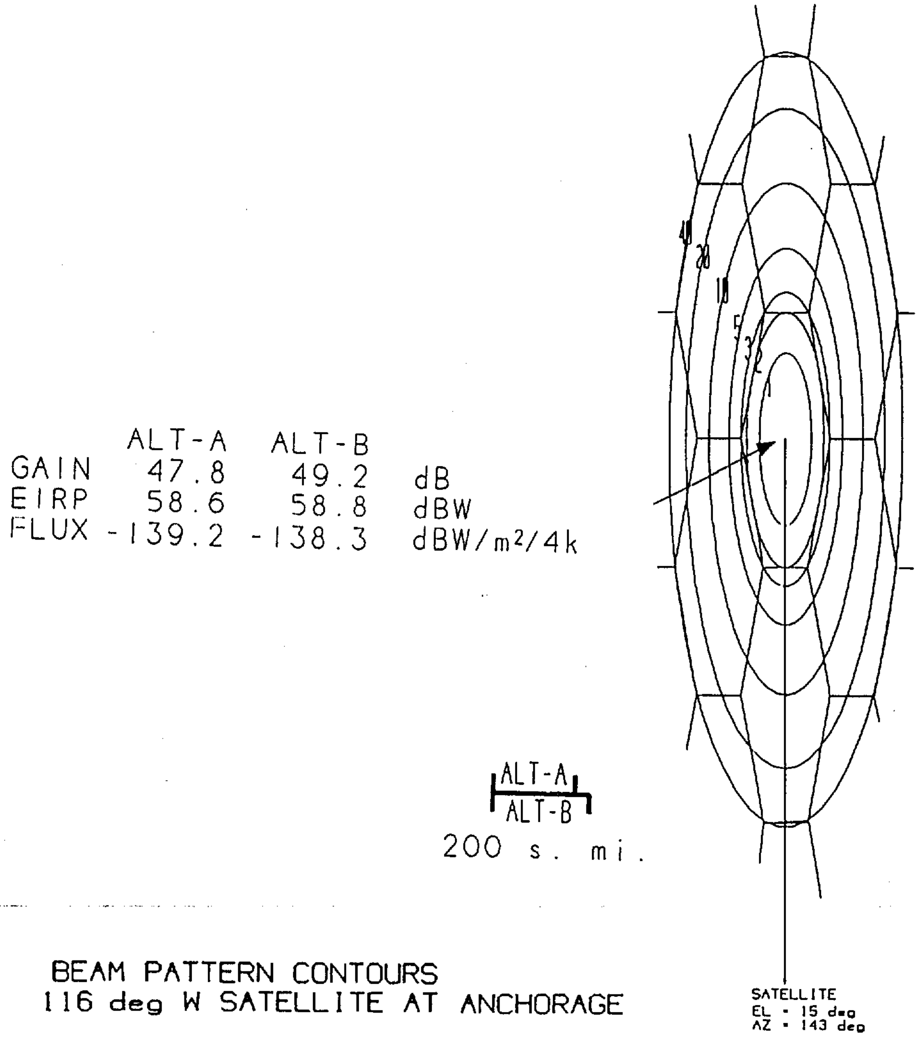


	ALT-A	ALT-B	
GAIN	47.8	49.2	dB
EIRP	58.6	58.8	dBW
FLUX	-139.1	-138.2	$dBW/m^2/4k$

FIGURE B-5

SATELLITE
EL = 20 deg
AZ = 125 deg

BEAM PATTERN CONTOURS
76 deg W SATELLITE AT SEATTLE



BEAM PATTERN CONTOURS
116 deg W SATELLITE AT ANCHORAGE

FIGURE B-6

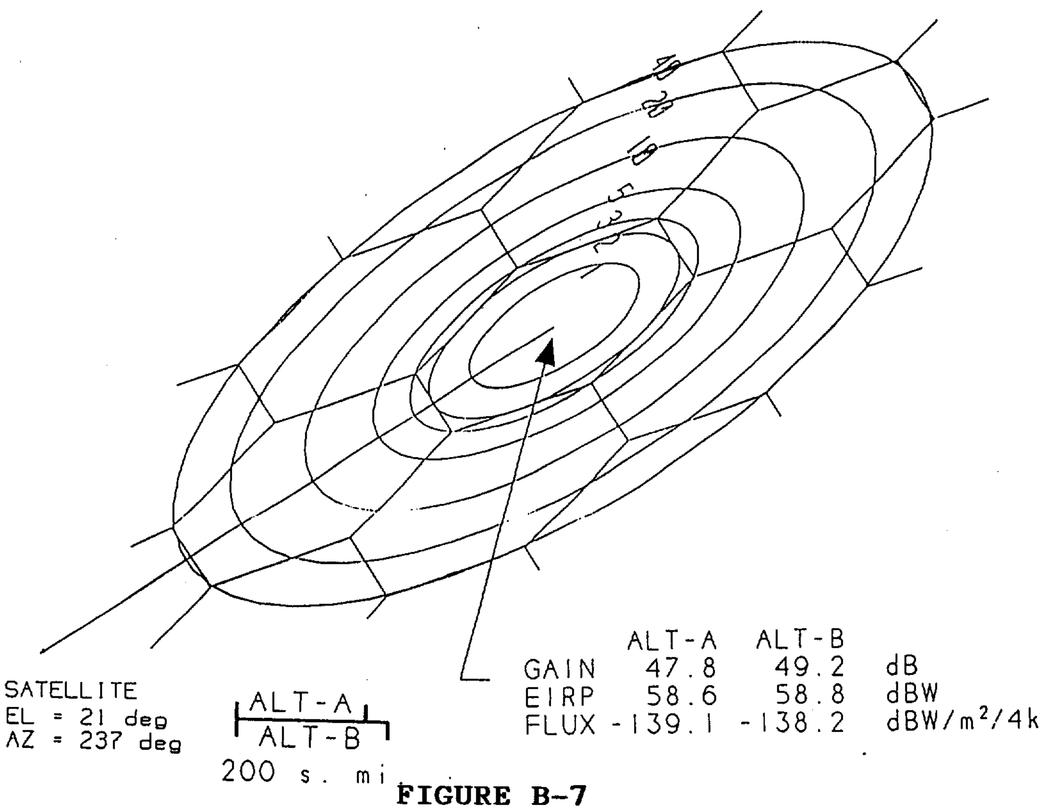
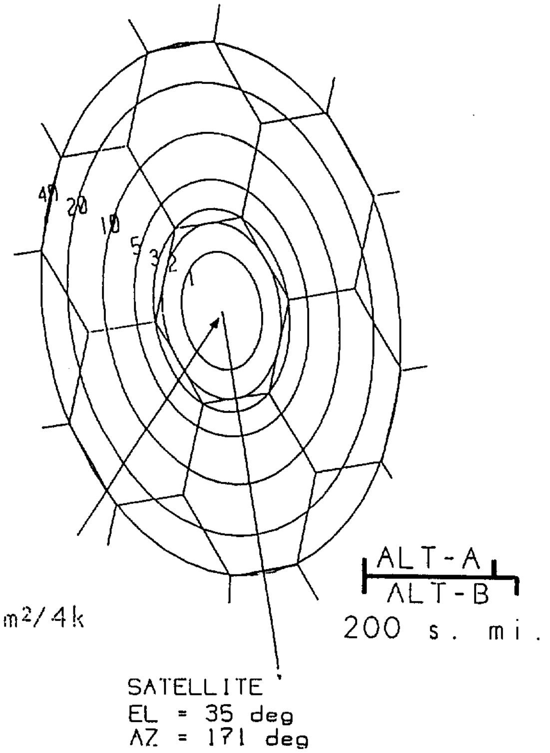


FIGURE B-7

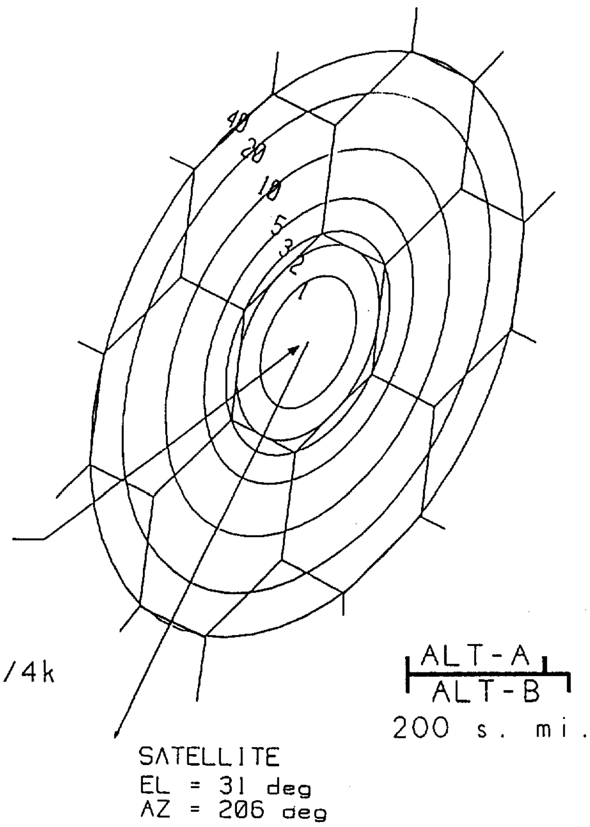
BEAM PATTERN CONTOURS
116 deg W SATELLITE AT BANGOR



	ALT-A	ALT-B	
GAIN	47.8	49.2	dB
EIRP	58.6	58.8	dBW
FLUX	-138.8	-137.9	dBW/m²/4k

BEAM PATTERN CONTOURS
116 deg W SATELLITE AT SEATTLE

FIGURE B-8



	ALT-A	ALT-B	
GAIN	47.8	49.2	dB
EIRP	58.6	58.8	dBW
FLUX	-138.9	-138.0	dBW/m²/4k

FIGURE B-9

BEAM PATTERN CONTOURS
116 deg W SATELLITE AT GRAND FORKS

APPENDIX -- C

APPENDIX C

CELSAT SUPPORT FOR RELAXATION OF PFD LIMIT

Discussion of the effects of increases in downlink power flux density (pfd) on terrestrial systems operating in both the 2.4/2.1 GHz band and the 1.6/2.5 GHz RDSS band are presented below. The pfd limits protecting fixed-service operations in both bands are set forth in Nos. 2556-57 of the International Radio Regulations. The limits are related to the angles of arrival from satellites at geostationary orbit. CELSAT's operations will involve angles down to about 10 degrees. The permitted flux densities in any 4-kHz band are given by two expressions in d, the arrival angle:

-154 + 0.5(d-5)	dBW/sq-m/4-kHz	for d between 5 and 25 degrees,
-144	dBW/sq-m/4-kHz	for d between 25 and 90 degrees.

These pfd limits hold for clear sky, direct line-of-sight conditions.

Operation in the RDSS Band

The effects of an increase in the pfd limit for **CELSAT**'s system on other systems in the RDSS downlink bands, 2483.5-2500 MHz is analyzed in this section (asssuming an L/S-Band HPCN allocation). The NTIA's 1984 report 1 concluded that an increase in pfd by 10 dB would not be detrimental to the existing systems in the 2025-2300 MHz band. There are long-haul systems having many hops in this band as well as vulnerable aero telemetry systems. Neither of these types of systems are licensed in the 2483.5-2500 MHz band and the NTIA report's conclusions would most likely have been more liberal if it were conducted in the RDSS band. We are proposing a relaxation by at least 6 dB, 0.6 dB more than than that shown in Table E-4, Mode 3 link budget in Appendix E used to obtain the more than 57,800 VG-channel capacity for a two-satellite deployment.

A cursory look at the Section 2.106 US Allocation Tables would seem to indicate that the RDSS user downlink band, 2483.5 to 2500 MHz, is allocated solely to this service on a primary basis. The three footnotes in the non-government allocation block permit other users. International footnote 752 designates the 2400-2500 MHz band to ISM use and, indeed this band is so allocated in the US (see, the Special-use Frequencies column of the table at the 2450-2483.5 MHz row and also Part 18 of the Commission's Rules). International footnote 753D specifies that RDSS is not allocated in Cuba. Footnote US41 permits conditional government radar use in the RDSS downlink band. Footnote NG147 grandfathers broadcast auxiliary and private radio users licensed (or applicants) prior to July 25, 1985 on a co-primary basis in the RDSS downlink band.

In addition, the adjacent-band allocations should be considered. Part 15 devices at the lower edge of the RDSS band and Part 74 operations at the upper edge have implications for RDSS operations. The possible effects on RDSS downlink band operations from all these sources as well as the effects of RDSS operations to the grandfathered users are discussed in the paragraphs that follow.

ISM Operations

Microwave ovens intended for home use are permitted to operate in the 2400-2500 MHz ISM band. These ovens employ magnetrons with a nominal center frequency of 2450 Mhz, determined solely by their cavity, and are powered by unfiltered, unregulated full-wave rectified AC derived from the mains voltage. The spectrum is rich in RF components having a 120-Hz line structure and having multiple center frequencies that the cavity supports as the magnetron voltage varies in a half-sinusiod manner from the rectified AC mains.

Several ovens were examined for the extent of their radiated power levels in the RDSS portion of their allotted band; i.e., the uppermost 16.5 MHz. A spectrum analyzer together with an antenna feed cable were calibrated at the -10 dBm level; the center frequency was set to 2492 MHz and verified using a CW source and a frequency counter. The sweep was set at 2 MHz/cm and the display covered 2482 to 2502 MHz, encompassing the RDSS band at a 300-kHz resolution bandwidth. A quarter-wave monopole mounted on a groundplane (dimensions 2 x 3 wavelengths at 2500 MHz) was used to sense the field radiated from the ovens. The antenna was estimated to have a 3-dBi gain and a capture area at 2500 MHz calculated to be 26 dB below one square meter. Measurements were made at distances from 8 to 30 feet from antenna to oven.

As the ovens warmed from a cold start, the power in the RDSS band varied markedly; this variation also occurred as the oven contents were varied. 2/ Measurements on a 200-Watt oven taken at 8 feet and through a window at 26 feet agreed closely, adjusting for the distances. Interpolation to 100 meters by square-law (spreading) losses indicated a flux density of -76 dBW/m^2 from 2482 to 2490 MHz, and then falling 20 dB in the upper half of the RDSS band. Another 200-Watt oven of different manufacture radiated 20 dB less in the lower half of the band but was nearly constant across the entire band. A larger, 600-Watt oven located 30 feet and four internal partition walls from the test antenna was measured; the interpolated density at 100 meters was -85 dBW/sq-m peak, varying 10 dB across the RDSS band.

These radiation levels are well above the levels encountered in RDSS service when operating at the prescribed -144 dBW/m^2/4-kHz power flux density level; in a 1.25 MHz subband, this becomes a level of -119 dBW/sq-m. Thus, while attempting to communicate within 100 meters of operating ovens, the user may suffer an interference level that is 20-30 dB higher than the satellite signal. A 100-meter separation is likely for pedestrian users in either residential areas, near restaurants, or near the cafeterias some business firms operate for their employees.

Adjacent-band Operations

Section 15.209 of the Rules permits Part-15 devices to radiate field strengths of 500 uV/m at 3 meters above 960 MHz. Of consequence to this discussion is the lower adjacent band 2400-2483.5 MHz which is now being investigated for unlicensed spread-spectrum devices. 3/ The restrictions of Section 15.205 take precedence over the out-of-band limits set forth in 15.247, but, nevertheless, at 100 meters, this translates to a flux density of -122 dBW/sq-m and is comparable with the -119 dBW/sq-m flux level in a subband that was discussed in the paragraph supra.

ITFS channel A-1 occupies the band from 2500-2506 MHz. Section 74.936 of the Rules requires that emissions more than 3 MHz from a channel edge be at least 30 dB below the visual carrier level, taken as 10 watts for most systems. No restrictions seem to apply within the 3 MHz, the portion of the RDSS band from 2497-2500 MHz and encompassing more than two of **CELSAT**'s proposed subbands. This matter aside, radiation lower than 2497 MHz at the -20 dBW level results in a flux density of -71 dBW/sq-m at 100 meters. Presumably, the Section 15.205 restriction rule applies to this situation for the 2483.5-2500 MHz band, for which the permissible level is -122 dBW/sq-m at 100 meters, but it's doubtful that ITFS transmitters can be filtered adequately to suppress their out-of-band radiation an additional 51 dB which, if it were possible, would still be comparable to RDSS signal levels as in the case of SS devices operating in the 2400-2483.5 MHz band.

Thus, **CELSAT** requests that the pfd limit be relaxed to permit the high capacity for which the system was designed. We request a relaxation of the limit by 6 decibels and propose to operate at a